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Appropriate Zooplankton Sampling Methodology
for OTEC Sites, Lawrence Berkeley Laboratory
Berkeley, CA, July 9-10, 1979

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APPROPRIATE ZOOPLANKTON SAMPLING METHODOLOGY
FOR OTEC SITES

July 1979

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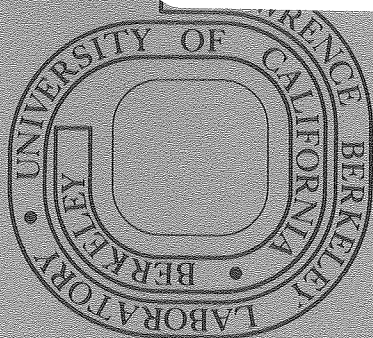
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Appropriate Zooplankton Sampling Methodology
for OTEC Sites

Edited by
M.L. Commins
A.J. Horne

Earth Sciences Division
Lawrence Berkeley Laboratory
University of California
Berkeley, CA 94720

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Note

Recorded herein are the recommendations agreed upon by the participants. However, since that time some of the participants have decided that they can no longer recommend some of the equipment and/or procedures, for example use of a 505 μ m mesh net with the Tucker trawl or even use of the Tucker trawl to sample zooplankton, particularly if an adequate number of replicates are taken using 202 μ mesh, 75 cm diameter single nets or Bongo nets.

Preface

This report presents the results of a meeting held July 9-10, 1979 under the auspices of the Marine Sciences Group, Lawrence Berkeley Laboratory. The purpose of the meeting was to decide upon a zooplankton sampling program recommended for use in conjunction with environmental monitoring of potential Ocean Thermal Energy Conversion (OTEC) sites.

Participants

J. McGowan - Chairman	Scripps Institute of Oceanography
A. Horne	Lawrence Berkeley Laboratory
M. Commins	Lawrence Berkeley Laboratory
J. Roth	Lawrence Berkeley Laboratory
C. Carmiggelt	Lawrence Berkeley Laboratory
K. Jones	Lawrence Berkeley Laboratory
A. Jones	Lawrence Berkeley Laboratory
V. Ramiah	Gulf Coast Research Laboratory
J. Steen	Gulf Coast Research Laboratory
T. Hopkins	University of South Florida
J. Bennett	University of South Florida
D. Pesante	University of Puerto Rico
D. Ziemann	AECOS
A. Cattell	AECOS

H. Michel (University of Miami), advisory board member, was unable to attend because of a prior commitment.

Introduction

The meeting began with an introduction by Pat Wilde who gave an overview of the OTEC program, and the policies of the federal government and Lawrence Berkeley Laboratory. A major point was that the program was initially set up very quickly by J. Sandusky and Horne to run for one year. After this changes were to be made culminating in a final design for fixed platform and free boat sampling. This was followed by a brief presentation by each of the subcontractors who described the methods being used, defined problems and made suggestions for improvement in the zooplankton sampling program.

Problems with current methods and suggested changes

Field

The same methods may not be appropriate for each site, for example, the Mobile (Gulf of Mexico) site has higher concentrations of zooplankton than other OTEC sites; therefore, an adequate sample can be obtained more quickly but the net will clog more readily. Studies should be made to determine the length of time for a maximum catch before clogging occurs. Oblique rather than vertical samples should be taken if only small numbers of organisms are present, and net hauls (at least for deep samples) should be opened at the beginning of the depth interval, lowered, then raised open; for example, it should fish at 800m - 1000m - 800m. This would increase the number of plankton caught. The larger the net the more abundance and diversity obtained so the larger the net the better (within practical limits).

Some small organisms are missed by current methods. For example, Microsetella, a very small harpacticoid copepod generally very abundant in surface samples, is not commonly found in our samples. For catching organisms smaller than 202 μ the use of water bottles (30 liter) and/or a pump was suggested. To catch larger organisms, and to better utilize the 202 μ size mesh, the use of a Tucker trawl was discussed.

A pump system could be used on a fixed platform in combination with a ship-towed Tucker trawl with appropriate mesh sizes to catch larger organisms. Tucker trawls must be towed from ships rather than a fixed platform. Because the Tucker trawl requires the use of a ship, is therefore expensive and it would be difficult to get sufficient replicates, it was suggested that net hauls from the platform could be made using the 0.75 m diameter, 202 μ net currently used by OTEC subcontractors. Many hauls from the platform could be made for relatively little expense. Although they are less accurate in sampling the plankton, enough samples could be taken to greatly reduce the variation, particularly that due to patches greater than 1 km across. Zooplankton tend to be very patchy and the number of samples currently being taken probably does not allow for this. It was suggested that many more replicate samples be taken at sea to accommodate patchiness with less attention paid to identification and enumeration of samples in the laboratory. In deep collections the net may remain stationary before the messenger arrives to close it and this may cause organisms to be "pumped out". Although

it is a good idea to have the net closing messenger arrive as soon as possible after the net stops fishing, it is likely that not much of the sample is lost through pumping because the net is probably streaming due to currents and movement of the ship.

Not all contractors are using an accurate method to determine the depth at which the sample is being taken. To more accurately determine the depth of the samples the time depth recorder (TDR) currently used by some contractors was suggested for all samples. Also discussed was the use of conducting cable for direct depth readout to the ship which is more sensitive than the pinger system. Due to its cost and need for special equipment (a slip-winch) conducting cable was not recommended at this time. Some workers suggested that flowmeters are not being triggered exactly at the beginning or stopped at the end of hauls. This may lead to inaccurate meter reading. A demonstration was given by Jim Bennett on how to rig and fold the net so that it remains folded in rough seas with the flowmeter tucked in to prevent the meter's rotor moving before the net is opened.

Laboratory

Measuring the length of all copepods is time consuming and only a rough estimate can be obtained. No methods have been set down for measuring other zooplankton. It was suggested that size measurements be discontinued since they are very tedious and most organisms caught by our methods are probably too small to clog the OTEC intake screen.

Biomass should be measured using dry weight, ash-free dry weight or displacement volume. Larval fish should be enumerated.

Recommendations

Field Sampling

From the various suggestions for improvement in the zooplankton program, a model for sampling zooplankton after the establishment of an OTEC platform was recommended (the findings are summarized in Table 1). It was realized that it is an idealized program and that the actual program implemented will be dependent on the availability of funds, personnel, and equipment.

Since zooplankton in at least some open ocean waters are stratified, samples should be taken from each station at the following depths

0 - 25m
25 - 200m
200 - 600m
600 - 1000m

Samples may be obtained in the following ways: On the platform;

samples are best taken with a pump, and this will adequately sample the small size ranges ($<200 \mu$). Though not ideal, the currently used 0.75m diam. 202 μ net might be used for larger size classes ($>202 \mu$) at a frequency to be determined by future experiments. From a ship, samples should ideally be taken using a Tucker trawl which will sample the mid to large size ranges ($>202 \mu$).

The pump can bring water up from about two hundred meters. It discharges into a manifold to a series of screens which sort the organisms by size. Recommended mesh sizes for the screens were 202 μ , 100 μ , and 35 μ . Below 200m the pump cannot operate, but this may not be important as the number of very small organisms drops off drastically below 200m. A time depth recorder should be on the intake pump and the intake should be slowly raised up through the water column, stopping at intervals. Because of water movement this will produce a stairstep sample, although oblique sampling is also acceptable. In the size range (35 μ - 202 μ) sampled by this method most of the organisms are unlikely to migrate very much vertically so the pump could be run day or night. Four replicates should be done at each depth range.

	# samples
0-25m	4
25-200m	4

The volume of water pumped should be the amount necessary to obtain 200 individuals of the most common types of organisms. Because water can be bled off as it is pumped up, phytoplankton, chlorophyll a, and nutrients can be determined from the same samples. The pump can be operated either through the use of conducting cable taped on the outside with friction tape or possibly by the use of a 12 volt car battery which could be sent down with the pump.

The Tucker trawl should consist of an inner net with a 202 μ mesh a 0.5m diameter and a 5:1 cone. The outside would be 2 x 2 m with a 505 μ mesh net. A time depth recorder should be attached. Each depth interval should be sampled using the stairstep method of oblique sampling. Two knots is the recommended towing speed and the length of tow will have to be varied with each site due to differential clogging but should be as long as possible. It was also recommended that four daily and four nightly replicates be taken except for the deepest samples where two day and two night samples would suffice.

Depth	# Day Replicates	Estimated Ship Time	# Night Replicates	Estimates Ship Time
0-25m	4	3 hours	4	3 hours
25m-200m	4	3.5 hours	4	3.5 hours
200m-600m	4	5 hours	4	5 hours
600m-1000m	2	4 hours	2	4 hours

It was estimated that these samples would require 48 hours of ship-time and that at least one on-site series, one off-site series in the predicted path of the plume, and one off-site series out of the plume would be needed. Samples should be taken every other month; however, it was realized that this may not be possible and that taking the samples quarterly might be sufficient. It was suggested that extra cruises be made where possible to sample at random the area surrounding OTEC sites.

If possible, pump samples similar to the ones on the platform, should be taken from the ship at the same time as the Tucker trawl.

It was suggested that experiments be done to determine the optimum design for the pump and trawl.

Sample Analysis

Laboratory analysis for every group of replicate samples (four in most cases) would be conducted by removing one-half of each sample for biomass determination by the displacement volume technique (after the large organisms (>2 cm) have been removed from the 202 mesh net samples). The other half of the sample would be used to identify and count major groups of organisms. From a representative sample one quarter should be used for more detailed taxonomic analysis to a level satisfactory for toxicity print studies. One quarter should be sent to LBL for analysis (see Fig. 1).

Table 1. Recommended Collection Methods for future OTEC Zooplankton

Type of Platform	Depth Range (m)	Size Class (μ)	Replication at each Depth Recommended	Equipment	Estimated Collection Time (days)
fixed, e.g., OTEC-1, Puerto Rico Barge	0-25 25-200	35-200 35-200	4 4	pump with sequential screen series, 202 μ , 100 μ , 35 μ mesh	n/a
	200-1000 all	35-200 < 35, >200		no recommendation* no recommendation*	
Ship	0-25 25-200 200-600 600-1000	200-500 >500 200-500 >500 200-500 >500	day/night 4/4 4/4 4/4 2/2	Tucker trawl with 2 nets: Inner net 5:1 cone, 0.5m diam. mouth 202 μ mesh Outer net 2m x2m mouth, 505 μ mesh	2

*It may be possible to continue the use of the 75 cm diameter 202 μ mesh opening and closing nets used in present OTEC work. Experiments will be needed to test this once platforms are in place.

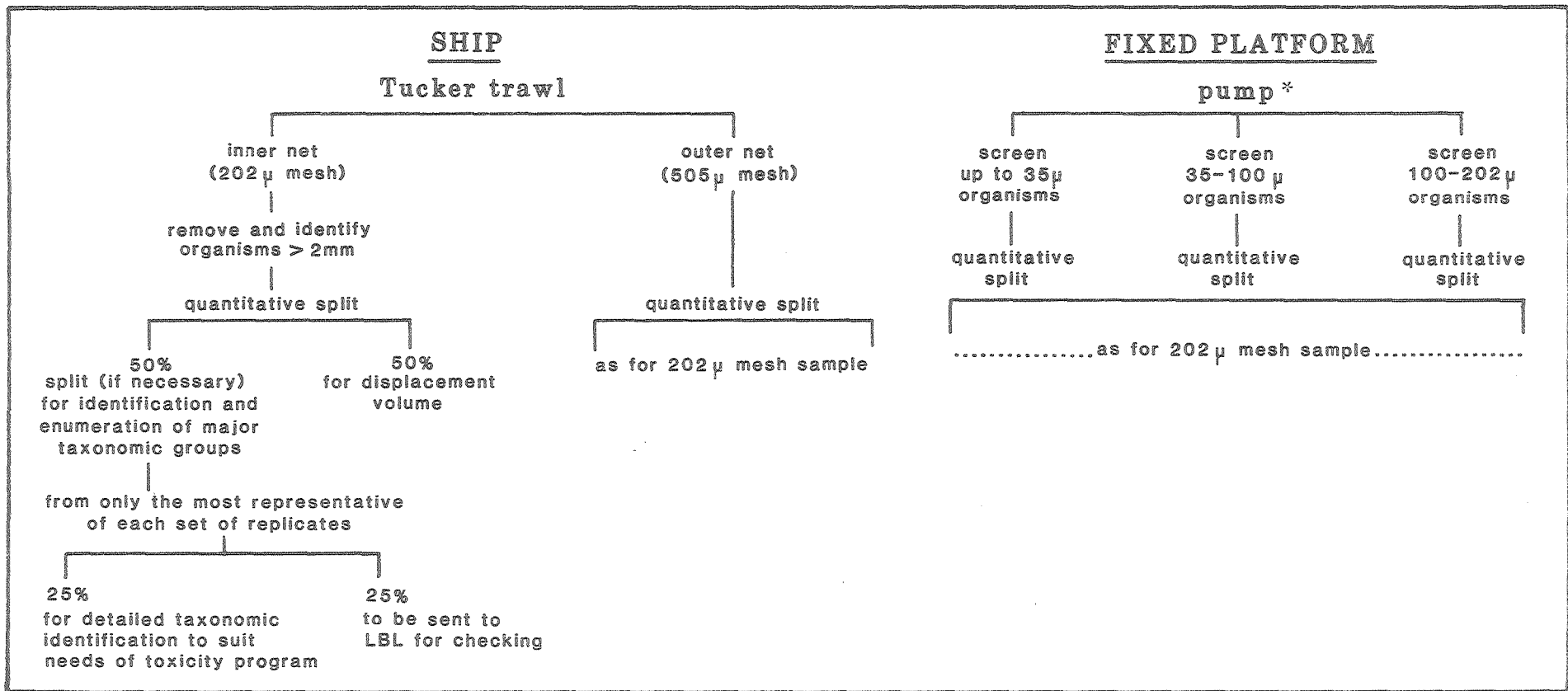


Figure 1. Laboratory analysis and counting methodology for future OTEC zooplankton samples (recommendations from the July 1979 conference).

This schedule is for a single sample at a single depth.

